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(71) Applicant: INTERNATIONAL FUEL CELLS, LLC [US/US]; 195 Governor's Highway, South Windsor, CT 06074 (US).

(72) Inventors: GRASSO, Albert, P.; 25 Hayes Drive, Vernon, CT 06066 (US). VAN DINE, Leslie, L.; 117 Plymouth Lane, Manchester, CT 06040 (US). VARTANIAN, George; 4 Hayes Avenue, Ellington, CT 06029 (US).

(74) Agent: CRENSHAW, Henry, T., Jr.; Intellectual Property Attorney, International Fuel Cells, LLC, 195 Governor's Highway, MS 601-03, South Windsor, CT 06074 (US).

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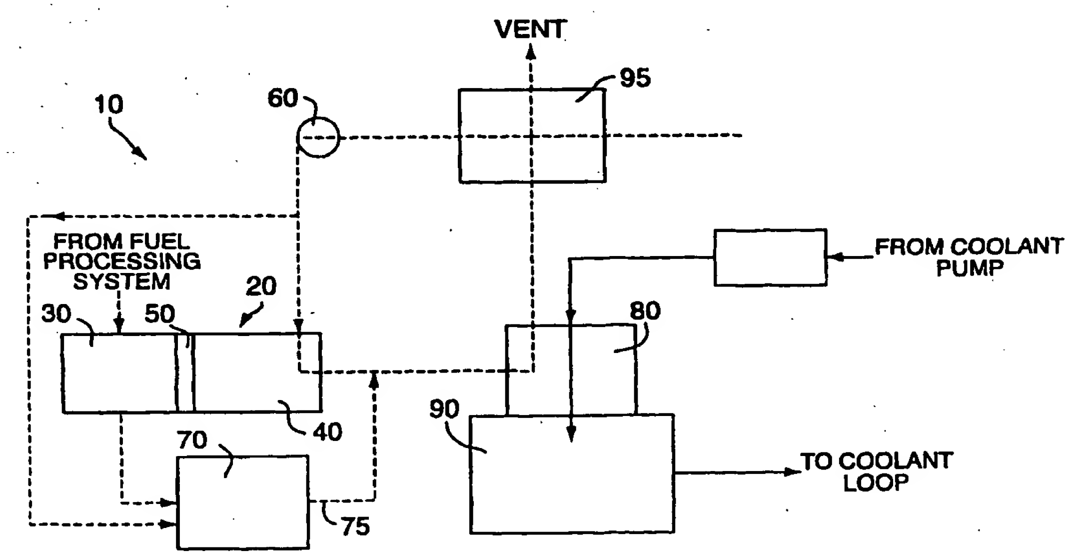
(54) Title: FUNCTIONAL INTEGRATION OF MULTIPLE COMPONENTS FOR A FUEL CELL POWER PLANT



(57) Abstract: A fuel cell power plant (10) having a plurality of functionally integrated components including a fuel cell assembly (20) provided with a fuel stream, an oxidant stream and a coolant stream. The fuel cell power plant (10) functionally integrates a mass and heat recovery device for promoting a transfer of thermal energy and moisture between a first gaseous stream and a second gaseous stream, and a burner (70) for processing the fuel exhausted from the fuel cell assembly (20) during operation thereof. A housing chamber is utilized in which the oxidant stream exhausted from the fuel cell assembly (20) merges with a burner gaseous stream exhausted from the burner. The resultant airflow from the common chamber is directed back to the mass and heat recovery device as the first gaseous stream.

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FUNCTIONAL INTEGRATION OF MULTIPLE COMPONENTS FOR A FUEL CELL POWER PLANT

TECHNICAL FIELD

This invention relates to a functional integration of multiple components for a fuel cell power plant, and in particular to such an integration where the strong characteristics of each component may be utilized to compensate for the weak characteristics of the other components.

BACKGROUND ART

Fuel cells can produce electricity through the interaction of a hydrogen rich gas (fuel) and an oxygen rich gas (oxidant). In a typical fuel cell an electrolyte is disposed between a cathode and an anode. One type of electrolyte well known in the art is the proton exchange membrane (hereinafter PEM). Other commonly known electrolytes include phosphoric acid or potassium hydroxide held within a porous, non-conductive matrix. In a PEM fuel cell, catalyst layers are formed between the membrane and each electrode to promote the desired electrochemical reaction. The catalyst is typically a carbon supported noble metal such as platinum or a noble metal alloy.

The hydrogen rich fuel is fed to the anode and reacts with the catalyst layer to form hydrogen ions and electrons. The hydrogen ions migrate through the PEM to the cathode while the electrons flow through an external circuit to the cathode. At the cathode, the oxygen-containing gas supply reacts with the hydrogen ions and the electrons to form water and release thermal energy.

The hydrogen rich fuel is often derived from hydrocarbon fuels such as methane, natural gas, gasoline or the like. The conversion of these hydrocarbons into hydrogen can be accomplished with a steam reformer or an autothermal reformer. The reformation process does not typically yield pure hydrogen, but instead produces hydrogen tainted with at least some impurities, such as carbon monoxide, CO, ammonia, NH_3, as well as significant quantities of carbon dioxide, CO_2. These contaminates can infect the fuel cell's coolant supply and degrade the performance of the fuel cell.

Consequently, systems have been provided that protect the fuel cell from a contaminated coolant supply, which is typically water. One such system is described in commonly owned U.S. Patent No. 4,344,850, issued to Grasso. Grasso's system for treating the coolant supply utilizes a separate filter and demineralizer for purifying a portion of the coolant supplied to the fuel cell assembly. A separate degasifier is also utilized to process the condensed water obtained from a humidified cathode exit stream.

Providing an effective coolant treatment system is complicated by the multitude of components in a fuel cell power plant and their effect on the overall weight, volume, and complexity of the system. These components can include multiple fuel cell assemblies arranged in series (i.e., cell stack assembly), an electrically insulating housing that defines reactant and coolant manifolds, a degasifier, a demineralizer, a steam reformer, and a heat exchanger. Integrating these components into a fuel cell power plant that must function within specific operating constraints can result in a complex and cumbersome structure.

One such operating constraint is the balance that must be maintained between the rate at which water is produced at the cathode, and the rate at which water is removed from the cathode or supplied to the anode. For example, if insufficient water is returned to the anode in a PEM fuel cell, portions of the PEM electrolyte may dry out. If insufficient water is removed from the cathode, the cathode may become flooded. Either situation can degrade the performance of the fuel cell.

Further complicating matters are the fuel processing components used to convert hydrocarbons into hydrogen. These components have their own water needs, such as a boiler that generates steam. Water made into steam in the boiler must be replaced by water recovered from the fuel cell power plant.

Condensing heat exchangers are often placed in the exhaust streams of a fuel cell power plant to aid in water recovery and retention. The exhaust is cooled to condense water from the exhaust so that the water may be returned to the power plant. An example of a PEM fuel cell with a condensing heat exchanger is shown in U.S. Patent No. 5,573,866 that issued on November 12, 1996, to Van Dine et al. In Van Dine et al., the heat exchanger

cools a cathode exhaust stream, which upon leaving a cathode chamber includes evaporated water that has passed through the PEM. The heat exchanger passes the cathode exhaust stream in heat exchange relationship with a stream of cooling ambient air, and then directs condensed water back to an anode side of the cell.

A limitation on condensing heat exchangers is their decreasing water recovery efficiency with ambient temperature increases. Moreover, such heat exchangers may not be effective when the ambient temperature is below the freezing point of water. Because water from such exchangers is often reintroduced into the PEM fuel cell, the water may not be mixed with conventional antifreeze to lower its freezing temperature. Propylene glycol and similar antifreezes would be adsorbed by the catalysts in the cells and decrease cell efficiency. It is therefore desirable to produce a fuel cell power plant that can achieve a self-sufficient water balance without a condensing heat exchanger.

DISCLOSURE OF THE INVENTION

A fuel cell power plant is provided having a plurality of functionally integrated components. The power plant includes a fuel cell assembly provided with a fuel stream, an oxidant stream and a coolant stream. A mass and heat recovery device promotes a transfer of thermal energy and moisture between a first gaseous stream and a second gaseous stream. A burner processes the fuel exhausted from the fuel cell assembly during operation thereof and exhausts a burner gaseous stream containing thermal energy and moisture. The oxidant stream exhausted from the fuel cell assembly merges with the burner gaseous stream to form said first gaseous stream in a housing chamber. In this way, a functional integration of multiple components of a fuel cell power plant is provided wherein the strengths of one component act to mitigate the weaknesses of another.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 illustrates a schematic illustration of a fuel cell power plant according to one embodiment of the present invention.

Fig. 2 is a cross-sectional view of a housing integrating multiple components of a fuel cell power plant according to one embodiment of the present invention.

Fig. 3 is an isometric illustration of the housing as depicted in Fig. 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An integrated fuel cell power plant according to the present invention is schematically illustrated in Fig. 1 and is generally designated by reference numeral 10. The fuel cell power plant 10 includes at least one fuel cell assembly 20 having an anode electrode 30, a cathode electrode 40 and an electrolyte 50 disposed there-between. By supplying a hydrogen rich fuel to the anode electrode 30 and an oxygen rich oxidant to the cathode electrode 40, the fuel cell assembly 20 will produce electrical energy in a manner well known in the art. In the preferred embodiment of the present invention, the fuel cell assembly 20 of Fig. 1 employs a proton exchange membrane ("PEM") as the electrolyte 50 which is coated on either side thereof with an unillustrated catalyst layer utilized to promote the electrochemical reaction within the fuel cell assembly 20.

The anode electrode 30 and the cathode electrode 40 may contain porous carbon-carbon fibrous composite substrates having a porosity of about 65% to about 75%, and may be wet-proofed by a hydrophobic substance such as Teflon®, as is known. The fuel cell assembly 20 may also contain unillustrated plates which provide the means for carrying the reactants to the electrodes.

While Fig. 1 depicts a single fuel cell assembly 20, the fuel cell power plant 10 may be alternatively operated in conjunction with a plurality of electrically coupled planar fuel cell assemblies forming a cell stack assembly that is encased within a non-illustrated housing that defines various reactant manifolds for directing a hydrogen rich fuel stream and an oxygen rich oxidant stream to and from the cell stack assembly. A coolant manifold system may also be provided to direct a coolant stream to and from the fuel cell assembly 20 or the cell stack assembly in a manner also well known in the art.

In operation, it is desired that pure hydrogen be utilized as the fuel supply for the fuel cell assembly 20 shown in Fig. 1. However, such pure hydrogen is often expensive to obtain and store. Other hydrocarbons such as, for example, methane, butane, propane, ethanol, natural gas, gasoline and the like are therefore utilized as a fuel, but only after these hydrocarbons have been processed by a known fuel processing system that converts these hydrocarbons to a hydrogen rich fuel. The hydrogen rich fuel is supplied to the anode electrode 30, as depicted in Fig. 1.

The fuel cell power plant 10 also includes an oxidant pump 60 for directing an inlet, oxygen-rich oxidant stream to the cathode electrode 40. A burner 70 provides the heat required by the fuel processing system, wherein the burner 70 utilizes diluted fuel exhausted from the anode electrode 30 and, in certain embodiments, oxidant from the oxidant pump 60 to produce the steam needed by the fuel processing system. A degasifier 80 acts in concert with the oxidant exhausted from the cathode electrode 40 to strip contaminants from the coolant exhausted from the fuel cell assembly 20, wherein the coolant is typically water circulated in a coolant loop in thermal contact with the fuel cell assembly 20. An accumulator 90 for provides a reservoir within which excess water may be stored for subsequent use, upon demand, by the fuel cell assembly 20. An enthalpy recovery device ("ERD") 95 provides the dual functions of thermal energy and water transfer between the inlet and the exhausted oxidant stream and a burner exhaust stream 75, thereby assisting in the humidification of the PEM of the fuel cell assembly 20. Although the degasifier 80 and the accumulator 90 are shown as distinct structural bodies in Fig. 1, in practical application they occupy a common housing which is in structural integration with the ERD 95, as will be described in more detail later in conjunction with Figs. 2 and 3.

The efficient operation of a PEM fuel cell assembly depends in large part on the water management of the fuel cell assembly, including maintaining a humidified PEM and disposing of excess water created within the fuel cell assembly during operation. In specific relation to the fuel cell power plant 10 of Fig. 1, as the fuel cell assembly 20 is operated, the oxidant exhausted from the cathode 40 will contain a measured amount of water, thermal energy and oxygen-containing gas. The present invention can utilize the oxidant stream

exhausted from the fuel cell assembly 20 and the burner exhaust stream from the burner to perform a multitude of beneficial operations. Moreover, the architecture of the fuel cell power plant 10 is arranged so as to integrate the strengths and weaknesses of each component of the fuel cell power plant 10, thereby achieving a more efficient and compact fuel cell power plant.

Fig. 2 illustrates a cross-sectional view of a housing 100 which integrates the ERD 95, the accumulator 90 and the degasifier 80, wherein the fuel cell assembly 20 of Fig. 1 is removed for clarity. As will be further described hereinafter, each component of the fuel cell power plant 10 is integrated into the housing 100 in a manner advantageous to the fuel cell power plant 10 as a whole. As noted previously, the fuel cell assembly 20 may be alternatively replaced with a cell stack assembly for use in connection with the fuel cell power plant of the present invention.

A major component of the integrated fuel cell power plant 10 of Fig. 1 is the ERD 95. The ERD 95 includes a support matrix that defines pores and a liquid transfer medium that fills the pores creating a gas barrier. The matrix is hydrophillic, and therefore capable of being wetted by the liquid transfer medium, while the pores themselves may be sized in the ranges of approximately 0.1 to 100 microns. While the matrix may be formed as a plurality of rigid, porous, graphite layers; rigid, porous, graphite-polymer layers; rigid, inorganic-fiber thermoset polymer layers; glass fiber layers; synthetic-fiber layers treated so as to be wettable; and perforated, metal layers having particulate matter suspended within the perforations, the present invention is not limited in this regard as other, alternative constructions are envisioned provided that the ERD 95 as a whole operates as an efficient exchanger of heat and mass capable of assuredly preventing the mixture of differing and adjacent gaseous streams.

The liquid transfer medium may be comprised of water, aqueous salt solutions, aqueous acid solutions and organic anti-freeze solutions, wherein the transfer medium is capable of absorbing fluid substances including, in particular, polar molecules such as water from a passing fluid stream composed of polar and non-polar molecules. The matrix itself should preferably be crafted as having a high thermal conductivity, thus assisting in the transfer of heat between adjacent gaseous streams.

As alluded to above, the ERD 95 acts as a heat and mass exchanger having porous wettable plates which eliminate gaseous stream crossover. In operation, the ERD 95 helps prevent water loss from the fuel cell power plant 10 by passing the inlet oxidant stream adjacent to the humid, exhausted gases from the fuel cell power plant 10, as will be described in more detail below.

As is best depicted in Fig. 2, a stream of inlet oxidant is either drawn or propelled by the unillustrated oxidant blower 60 through an inlet ERD manifold 98. In transportation applications, this inlet oxidant stream may be obtained from the ambient air surrounding the vehicle, thereby having differing degrees of humidity and frequently being somewhat arid. The inlet oxidant stream passes through the ERD 95 in a counter-current manner to the now-humidified, exhausted gases exiting from the fuel cell assembly 20 via an oxidant exit manifold 42. The close association between these two gaseous streams within the ERD 95 allows water vapor and entrained water molecules in the exhausted gases to migrate to and humidify the inlet oxidant stream. Thermal exchange will also take place within the ERD 95 between the inlet oxidant stream and the exhausted gases, thereby lowering the temperature of the exhausted gases. As will be appreciated by one of ordinary skill in the art, the more arid the inlet oxidant stream is, the greater the rate of humidification and heat transfer will be with the exhausted gases.

Among the important aspects of the present invention, therefore, is the ability of the integrated ERD 95 to provide the fuel cell assembly 20 with a humidified inlet oxidant stream, as well as lowering the temperature of the gases exhausted from the fuel cell power plant 10. Moreover, the integrated ERD 95 inherently and automatically compensates for inlet oxidant streams having differing levels of humidity by promoting a greater or lesser rate of water and thermal transfer in dependence upon the humidity of the inlet oxidant stream.

Returning to Figs. 1 and 2, it will be apparent that the exhausted gas stream entering the housing 100 via the oxidant exit manifold 42 is not directly provided to the ERD 95, rather it is first channeled through a chamber 110. The chamber 110 houses the accumulator 90, the degasifier 80, and provides an inlet opening 72 for accepting inlet gases from the burner 70. The gases

discharged from the burner 70 are typically high in temperature and require lowering prior to exhausting these gases to the outside, as well as containing a significant amount of water vapor which may be advantageously utilized, as will hereinafter be described. It will be readily appreciated that the portion of the chamber 110 acting as the degasifier 80 may be formed as any known mass transfer device capable of effecting mass transfer between a liquid stream and a gas stream. Examples of such mass transfer devices are packed beds, wetted films, spray towers, or the like.

The chamber 110 is also provided with a coolant inlet 94 for accepting used coolant from the fuel cell assembly 20, and a coolant egress 92 for re-supplying the coolant back to the fuel cell assembly 20. The present invention advantageously mixes the burner exhaust, the exhausted coolant stream and the oxidant exhaust from the fuel cell assembly 20 within the chamber 110, so as to increase the overall performance of the fuel cell power plant 10. A level sensor 98, or the like, is also provided to the chamber 110.

In operation, as the heated and humidified gases exhausted from the fuel cell assembly 20 enter the chamber 110, they come into cross-current contact with the exhausted and contaminated coolant from the fuel cell assembly 20. The exhausted coolant can become contaminated in response to the typical utilization of reformed hydrocarbon fuels as one of the input reactants to the fuel cell power plant 10. These reformed hydrocarbon fuels typically contain quantities of ammonia, NH_3, and hydrogen, H_2, as well as significant quantities of carbon dioxide, CO_2. The NH_3 and CO_2 gases tend to dissolve and dissociate into the water coolant which may be provided to, and created within, the fuel cell assembly 20. The gases react with the water and form ionic reaction by-products. In addition, water within the fuel cell assembly 20 containing concentrations of ammonia even as small as 2 parts per million (ppm) can act to displace protons in the PEM 50, thereby reducing the conductivity of the PEM 50 and thus, the efficiency of the fuel cell power plant 10 as a whole. High solubility dissolved gases, such as NH_3 and CO_2, within the water may also result in large gas bubbles in the coolant stream of the fuel cell assembly 20 which may cause drying of the anode and cathode porous plates, thereby resulting in mixing of the reactants. For these reasons, the degasifier 80 is utilized to strip contaminants which may have dissolved or

dissociated into the coolant stream of the fuel cell power plant 10 during operation.

Returning to Fig. 2, as the heated and humidified gases exhausted from the fuel cell assembly 20 enter the chamber 110 and come into cross-current contact with the contaminated coolant from the fuel cell assembly 20 in the presence of the degasifier 80, significant quantities of the NH_3, H_2 and CO_2 gases are striped from the coolant stream. The configuration of the housing 100 assists this operation as the vigorous action of the exhausted coolant stream striking an upper portion 96 of the chamber 110 provides the mass transfer device of the degasifier 80 with a shower of coolant having a large surface area, thereby promoting a more efficient reduction of contaminants from the exhausted coolant stream. As the airflow within the chamber 110 continues to flow, it comes into contact with the exhaust gases from the burner 70 via the inlet opening 72. In doing so, the airflow absorbs both thermal energy and humidity from the inlet burner gases. At this point, the airflow is provided to the ERD 95 where, as discussed previously, a portion of the thermal energy and humidity of the airflow is transferred to the inlet oxidant stream. After circulating through the ERD 95, the now-cooled airflow is subsequently vented to the outside via a process exhaust pipe 82.

One important aspect of the present invention, therefore, is that contaminants are effectively striped from the coolant supply and exhausted from the fuel cell power plant 10 via the process exhaust pipe 82. It should be noted that the contaminants travelling with the airflow do not migrate to the inlet oxidant stream due to the wetted matrix of the ERD 95 which prohibits this action. Moreover, the excess humidity added by the burner exhaust to the airflow as it passes through the chamber 110 assists this operation by ensuring that the matrix of the ERD 95 stays sufficiently humidified, while also providing an additional measure of water to help humidify the inlet oxidant stream.

Another important aspect of the present invention lies in locating the accumulator 90 and the degasifier 80 within the common chamber 110, in contact with both the burner exhaust stream and the coolant supply. With such a configuration, it becomes possible to compactly remove contaminants from the exhausted coolant while providing the integrated accumulator 90 with

a ready supply of cleansed coolant for subsequent resupply to the fuel cell assembly 20 as needed. Furthermore, the moisture added to the airflow via the burner inlet opening 72 promotes the condensation of water within the chamber 110, thereby conserving even more of the water important for operation of the fuel cell power plant 10. An unillustrated overflow pipe is provided to the chamber 110 to dispose of excess water within the accumulator 90.

Previously known fuel cell systems either vented the burner exhaust to the outside without utilizing the moisture therein, or enlisted separate heat exchangers and moisture recovery devices for this purpose. Therefore, yet another important aspect of the present invention is the efficient use of fuel cell power plant thermal energy and moisture, while reducing the number of components necessary to accomplish such a goal. Specifically, the present invention eliminates the need for a separate burner exhaust heat exchanger by cooling the burner exhaust gaseous stream with other existing fuel cell power plant gaseous streams. In doing so, the fuel cell power plant of the present invention operates more efficiently than has heretofore been known in the art, while simultaneously reducing both the weight and volume of the fuel cell power plant as a whole.

Another important aspect of integrating the burner exhaust into the common chamber 110, apart from no longer requiring a separate heat exchanger, lies in the ability of such a system to ensure that a sufficient amount of moisture will be available to humidify the inlet oxidant stream. This is accomplished, in direct fashion, by the burner exhaust itself adding a measured amount of moisture to the chamber 110, as well as in indirect fashion owing to the increased amount of moisture that the airflow leaving the chamber 110 is capable of absorbing.

It has been discovered that by blending the heated burner exhaust with the exhausted oxidant stream and the coolant, the airflow leaving the chamber 110 for the ERD 95 will be approximately 5°F (2.8°C) higher than would otherwise be the case. The resultant airflow leaving the chamber 110 for the ERD 95 will therefore be proportionally higher in moisture, given the linear relationship between higher airflow temperatures and the increasing capacity of the airflow to carry entrained moisture.

Fig. 3 illustrates a perspective view of the housing 100, according to one embodiment of the present invention. It will be readily appreciated that the inlet ERD manifold 98 may include a filter to ensure that contaminants, including air borne particulate, are prohibited from entering the fuel cell power plant 10.

As can be seen from the foregoing disclosure and figures in combination, a functionally integrated fuel cell power plant according to the present invention is advantageously provided with a plurality of beneficial operating attributes, including, but not limited to: humidifying the inlet oxidant stream, lessening the weight and volume of a fuel cell power plant as a whole and cleansing the coolant within the overall system to remove potentially harmful and debilitating contamination. All of these attributes contribute to the efficient operation of a fuel cell power plant and are especially beneficial to those applications, such as motor vehicle manufacturing, which demand high performance, reliability and low volume and weight.

CLAIMS

1. A fuel cell power plant having a plurality of functionally integrated components including a fuel cell assembly provided with a fuel stream, an oxidant stream and a coolant stream, said fuel cell power plant further comprising:

a mass and heat recovery device for promoting a transfer of thermal energy and moisture between a first gaseous stream and a second gaseous stream;

a burner for processing said fuel exhausted from said fuel cell assembly during operation thereof and exhausting a burner gaseous stream containing thermal energy and moisture; and

a housing chamber in which said oxidant stream exhausted from said fuel cell assembly merges with said burner gaseous stream to form said first gaseous stream.

2. The fuel cell power plant having a plurality of functionally integrated components according to claim 1, wherein:

said coolant stream exhausted from said fuel cell assembly is provided to said housing chamber, wherein said oxidant stream exhausted from said fuel cell assembly merges with said burner gaseous stream in the presence of said exhausted coolant stream.

3. The fuel cell power plant having a plurality of functionally integrated components according to claim 2, wherein:

said oxidant stream is provided to said mass and heat recovery device prior to being provided to said fuel cell assembly; and

said second gaseous stream is comprised of said oxidant stream.

4. The fuel cell power plant having a plurality of functionally integrated components according to claim 3, wherein:

said first gaseous stream is provided to said mass and heat recovery device in a counter-current manner to said second gaseous stream, wherein said second gaseous stream absorbs thermal energy and moisture from said first gaseous stream.

5. The fuel cell power plant having a plurality of functionally integrated components according to claim 2, wherein:

said housing chamber further comprising a degasifying portion and an accumulator portion.

6. The fuel cell power plant having a plurality of functionally integrated components according to claim 5, wherein:

said degasifying portion cleanses said exhausted coolant stream by promoting striping of contaminants from said exhausted coolant stream; and

said accumulator collects said cleansed coolant stream.

7. The fuel cell power plant having a plurality of functionally integrated components according to claim 6, wherein:

said degasifying portion comprising one of a packed bed, a wetted film and a spray tower.

8. The fuel cell power plant having a plurality of functionally integrated components according to claim 4, wherein:

said first gaseous stream is vented from said fuel cell power plant subsequent to interacting with said second gaseous stream.

9. The fuel cell power plant having a plurality of functionally integrated components according to claim 1, wherein:

said mass and heat recovery device is comprised of a hydrophillic matrix having pores formed therein, said pores adapted to be filed with a liquid transfer medium; and

said liquid transfer medium comprising one of an aqueous salt solution, an aqueous acid solution, an organic antifreeze solution and water.

10. A fuel cell power plant having a plurality of functionally integrated components including a cell stack assembly having a plurality of fuel cell assemblies in electrical communication with one another, wherein said cell stack assembly is provided with a fuel stream, an oxidant stream and a coolant stream, said fuel cell power plant comprising:

a mass and heat recovery device for promoting a transfer of thermal energy and moisture between a first gaseous stream and a second gaseous stream;

a burner for processing said fuel exhausted from said cell stack assembly during operation thereof and exhausting a burner gaseous stream containing thermal energy and moisture; and

a housing chamber in which said oxidant stream exhausted from said cell stack assembly merges with said burner gaseous stream to form said first gaseous stream.

11. The fuel cell power plant having a plurality of functionally integrated components according to claim 10, wherein:

said coolant stream exhausted from said cell stack assembly is provided to said housing chamber, wherein said oxidant stream exhausted from said cell stack assembly merges with said burner gaseous stream in the presence of said exhausted coolant stream.

12. The fuel cell power plant having a plurality of functionally integrated components according to claim 11, wherein:

said oxidant stream is provided to said mass and heat recovery device prior to being provided to said cell stack assembly; and

said second gaseous stream is comprised of said oxidant stream.

13. The fuel cell power plant having a plurality of functionally integrated components according to claim 12, wherein:

said first gaseous stream is provided to said mass and heat recovery device in a counter-current manner to said second gaseous stream, wherein said second gaseous stream absorbs thermal energy and moisture from said first gaseous stream.

14. The fuel cell power plant having a plurality of functionally integrated components according to claim 11, wherein:

said housing chamber further comprising a degasifying portion and an accumulator portion.

15. The fuel cell power plant having a plurality of functionally integrated components according to claim 14, wherein:

said degasifying portion cleanses said exhausted coolant stream by promoting striping of contaminants from said exhausted coolant stream; and

said accumulator collects said cleansed coolant stream.

16. The fuel cell power plant having a plurality of functionally integrated components according to claim 15, wherein:

said degasifying portion comprising one of a packed bed, a wetted film and a spray tower.

17. The fuel cell power plant having a plurality of functionally integrated components according to claim 13, wherein:

said first gaseous stream is vented from said fuel cell power plant subsequent to interacting with said second gaseous stream.

18. The fuel cell power plant having a plurality of functionally integrated components according to claim 10, wherein:

said mass and heat recovery device is comprised of a hydrophillic matrix having pores formed therein, said pores adapted to be filed with a liquid transfer medium; and

said liquid transfer medium comprising one of an aqueous salt solution, an aqueous acid solution, an organic antifreeze solution and water.

19. A method of functionally integrating components of a fuel cell power plant, said fuel cell power plant including a fuel cell assembly supplied with and exhausting a fuel stream, an oxidant stream and a coolant stream, and a burner for processing said exhausted fuel stream and issuing therefrom a burner gaseous stream, said method comprising the steps of:

merging said exhausted oxidant stream, said burner gaseous stream and said exhausted coolant stream in a common chamber, said common chamber exhausting a chamber gaseous stream therefrom;

providing a mass and heat recovery device for promoting a transfer of thermal energy and moisture between adjacent gaseous streams;

orientating said common chamber and said mass and heat recovery device to be in fluid communication with one another;

passing said oxidant stream through said mass and heat recovery device prior to supplying said oxidant stream to said fuel cell assembly; and

passing said chamber gaseous stream through said mass and heat recovery device in a counter-current manner to said oxidant stream.

20. A method of functionally integrating components of a fuel cell power plant, said fuel cell power plant including a cell stack assembly having a plurality of fuel cell assemblies in electrical communication with one another, wherein said cell stack assembly is supplied with and exhausts a fuel stream, an oxidant stream and a coolant stream, said fuel cell power plant further including a burner for processing said exhausted fuel stream and issuing therefrom a burner gaseous stream, said method comprising the steps of:

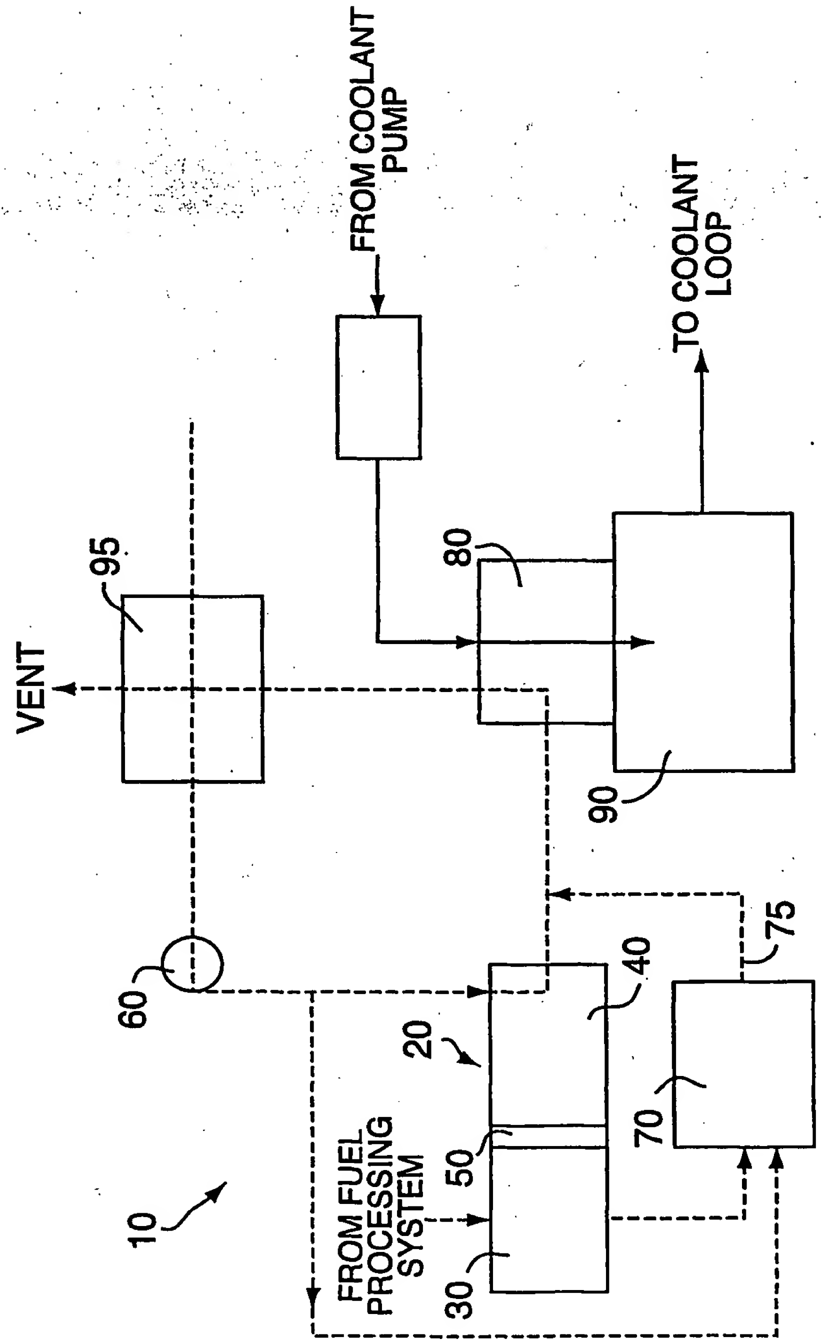
merging said exhausted oxidant stream, said burner gaseous stream and said exhausted coolant stream in a common chamber, said common chamber exhausting a chamber gaseous stream therefrom;

providing a mass and heat recovery device for promoting a transfer of thermal energy and moisture between adjacent gaseous streams;

orientating said common chamber and said mass and heat recovery device to be in fluid communication with one another;

passing said oxidant stream through said mass and heat recovery device prior to supplying said oxidant stream to said cell stack assembly; and

passing said chamber gaseous stream through said mass and heat recovery device in a counter-current manner to said oxidant stream.


FROM COOLANT PUMP
TO COOLANT LOOP
VENT
95
80
90
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40
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70
75
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30
FROM FUEL PROCESSING SYSTEM

FIG. 1

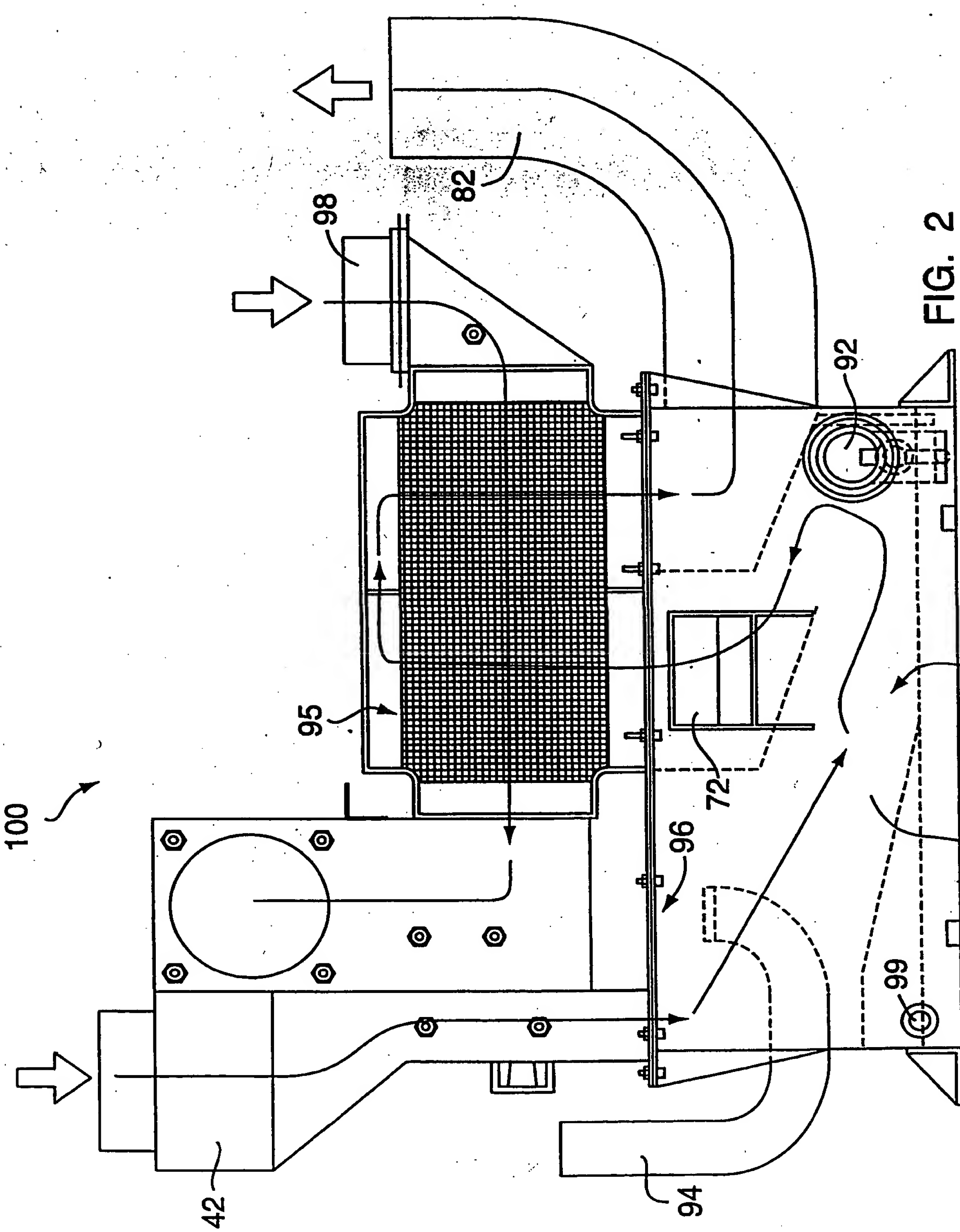

FIG. 2

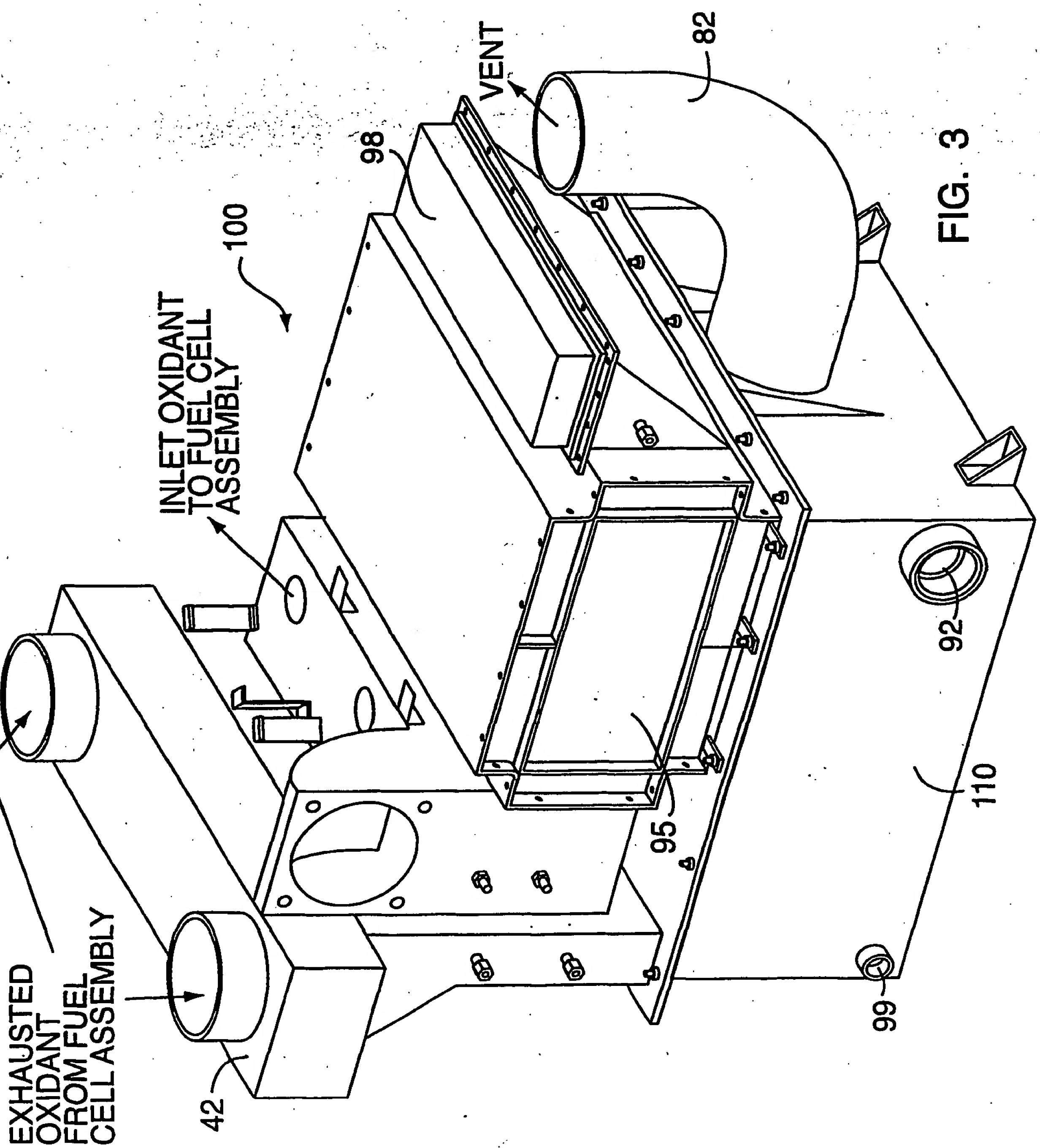
VENT
82
98
100
INLET OXIDANT TO FUEL CELL ASSEMBLY
EXHAUSTED OXIDANT FROM FUEL CELL ASSEMBLY
42
95
92
110
99

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/10730

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :H01M 8/06
US CL :429/17
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 429/17, 13, 20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,007,931 A (FULLER ET AL) 28 December 1999, see col. 5, line 59-col. 8, line 26; col. 9, lines 27-60 and Fig. 1.	1, 9, 10, 18
X, P	US 6,171,718 B1 (MURACH ET AL.) 09 January 2001, see col. 6, line 15-col. 7, line 41 and Fig 1.	1, 10
A	US 4,344,850 A (GRASSO) 17 August 1982	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
04 JULY 2001	02 AUG 2001

Name and mailing address of the ISA/US	Authorized officer
Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	JOHN S. MAPLES
Facsimile No. (703) 305-3230	Telephone No. (703) 308-0661

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